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ACCELERATION OF THE DEIONIZATION OF A RAREFIELD GAS BY 1/1

REVERSE VOLTAGE(U) FOREIGN TECHNOLOGY DIV

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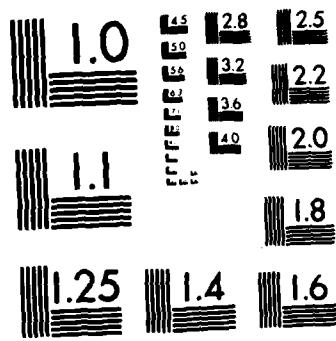
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FOREIGN TECHNOLOGY DIVISION



ACCELERATION OF THE DEIONIZATION OF A RAREFIELD GAS BY
REVERSE VOLTAGE

by

B.G. Mendelev

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HUMAN TRANSLATION

FTD-ID(RS)T-0826-86

21 August 1986

MICROFICHE NR: FTD-86-C-002115

ACCELERATION OF THE DEIONIZATION OF A RAREFIELD GAS
BY REVERSE VOLTAGE

By: B.G. Mendelev

English pages: 5

Source: Zhurnal Tekhnicheskoy Fiziki, Vol. 21, Nr. 6,
1951, pp. 710-712

Country of origin: USSR

Translated by: John A. Miller

Requester: FTD/TQTD

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| Block | Italic | Transliteration | Block | Italic | Transliteration |
|-------|------------|-----------------|-------|------------|-----------------|
| А а | А а | А, a | Р р | Р р | Р, r |
| Б б | Б б | Б, b | С с | С с | С, s |
| В в | В в | В, v | Т т | Т т | Т, t |
| Г г | Г г | Г, g | У у | У у | У, u |
| Д д | Д д | Д, d | Ф ф | Ф ф | Ф, f |
| Е е | Е е | Ye, ye; E, e* | Х х | Х х | Kh, kh |
| Ж ж | Ж ж | Zh, zh | Ц ц | Ц ц | Ts, ts |
| З з | З з | Z, z | Ч ч | Ч ч | Ch, ch |
| И и | И и | I, i | Ш ш | Ш ш | Sh, sh |
| Й и | Й и | Y, y | Щ щ | Щ щ | Shch, shch |
| К к | К к | K, k | Ь ъ | Ь ъ | " |
| Л л | Л л | L, l | Ѣ Ѣ | Ѣ Ѣ | Y, y |
| М м | М м | M, m | Ѥ Ѥ | Ѥ Ѥ | ' |
| Н н | Н н | N, n | Ѧ Ѧ | Ѧ Ѧ | E, e |
| О о | О о | O, o | Ѧ Ѩ | Ѧ Ѩ | Yu, yu |
| П п | П п | P, p | Ѧ Ѧ | Ѧ Ѧ | Ya, ya |

*ye initially, after vowels, and after ъ, Ѥ; е elsewhere.
When written as ё in Russian, transliterate as ўе or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

| Russian | English | Russian | English | Russian | English |
|---------|---------|---------|---------|----------|--------------------|
| sin | sin | sh | sinh | arc sh | sinh ⁻¹ |
| cos | cos | ch | cosh | arc ch | cosh ⁻¹ |
| tg | tan | th | tanh | arc th | tanh ⁻¹ |
| cтg | cot | cth | coth | arc cth | coth ⁻¹ |
| sec | sec | sch | sech | arc sch | sech ⁻¹ |
| cosec | csc | csch | csch | arc csch | csch ⁻¹ |

| Russian | English |
|---------|---------|
| rot | curl |
| lg | log |

GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

ACCELERATION OF THE DEIONIZATION OF A RAREFIED GAS BY REVERSE VOLTAGE

B. G. Mendelev

To estimate the influence of reverse voltage on the movement of deionization in a gas-discharge device, we can examine the ratio of the ion concentration at a given moment at a given point in the absence of reverse voltage $n(t_1, \vec{r})_{U_{\text{app}}=0}$ to the ion concentration at this same point and at that moment of time when reverse voltage is applied $n(t_1, \vec{r})_{U_{\text{app}}}$. Let us call this ratio $\xi(t_1, \vec{r})$ the field factor.

$$\xi(t_1, \vec{r}) = \frac{n(t_1, \vec{r})_{U_{\text{app}}=0}}{n(t_1, \vec{r})_{U_{\text{app}}}}. \quad (1)$$

Obviously, the field factor shows how much the presence of reverse voltage decreases the charge concentration at a given point.

In a previous work [1] we showed experimentally that a) the effect of the anode field is limited by the layer adjacent to it, and b) with time, this effect spreads to points ever further away from it. These experiments showed no acceleration of deionization by reverse voltage to the moment t' when the layer reaches the given point.

But as soon as the examined point appears in the layer, there should actually occur an abrupt reduction in charge concentration in

it since, unlike plasma, where random motion of ions occurs at thermal velocity, in the layer there is directed motion of the ions to the anode at a velocity which is the greater, the further the layer boundary moves from this point.

It should be stressed that information on the movement of deionization can be obtained relatively easily from that of a probe current only up to moment τ' . After this moment the probe current ceases to be a random ion current. There is redistribution of the ion current between the probe and the anode, which is very difficult to take into consideration. Therefore, it is practically impossible to obtain, directly from oscillograms of the probe current, information on acceleration of the reverse-voltage induced movement of deionization. However, if we experimentally obtain values of δ (the distance of the layer boundary from the anode) for various moments of time, using these data we can calculate the ion concentration at a given point and then determine how it appears in the layer. If the process occurs at sufficiently low pressure, we can use the "3/2 law" for this calculation. We know that if the distance between a flat anode and a charge emitter (the layer boundary plays this role in our case) is equal to δ , while the current is limited by the "3/2 law," at distance y from the anode the space charge density can be expressed by the formula

$$\rho(y) = \frac{U}{81 \cdot \pi \cdot 10^{11} \cdot \delta^{5/2} (3-y)^{1/2}} \quad (2)$$

where U is the voltage between the anode and the charge source, equal in our case to the reverse voltage [1].

If, as was shown in [1], for the time interval $t=60-400 \mu s$, we can assume

$$\delta(t) = A + at,$$

then in this interval

$$\rho(y, t) = \frac{U}{81 \cdot \pi \cdot 10^{11} (A + at)^{4/3} (A + at - y)^{1/3}} \quad (3)$$

The values in formulas (2) and (3) are expressed in coulombs/cm³, centimeters, volts, and seconds.

At the moment the layer reaches the point at which we are to calculate the concentration formula (2) gives $\rho = \infty$. Naturally, this is really not so, but is obtained because of the approximate nature of the "3/2 law" due to the lack of initial velocities in the charge carriers. Actually, ρ should be assumed equal to the charge concentration at this moment in a plasma that is unperturbed by the field.

At the low pressures at which these discussions are valid we can also consider that in the absence of reverse voltage the motion of deionization is exponential [2] with time constant η . Therefore, the field factor, in accordance with (1) and (2),

$$\xi(t, y) = \begin{cases} 1 \text{ при } t < \tau'; y > \delta \\ 1.3 \cdot 10^{-6} \cdot \pi \cdot n(0) \cdot e^{-\frac{t}{\tau}} \delta^6 (\delta - y)^6 U^{-1} \\ \text{при } t > \tau'; y < \delta. \end{cases} \quad (4)$$

Key: при = when

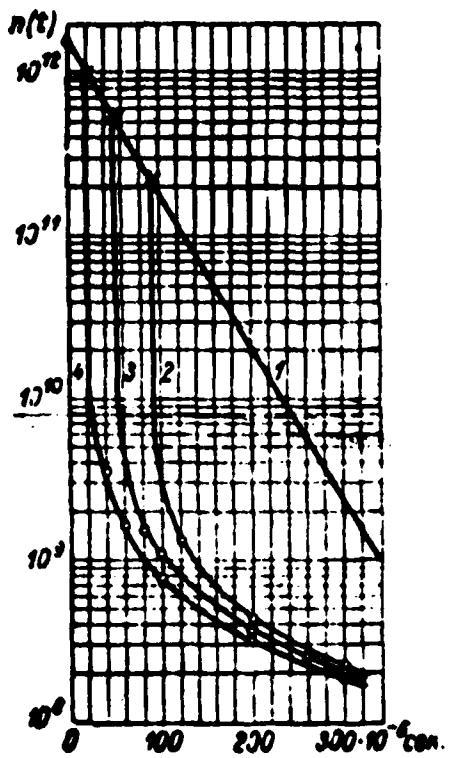
In our previous work [1] we experimentally obtained data on $\delta(t)$ in an experimental cylindrical tube with diameter 70 mmHg, filled with mercury vapors.

The figure shows, by way of example, the movement of ion concentration in this tube, calculated using data from formula (2), at a point 20 mm from the anode with various reverse voltages. The values of τ , and $n(0)$ were obtained by us in the manner described previously [1], experimentally from the probe-current oscillograms.

REFERENCES

1. B. G. Mendelev, L. A. Svyatoyezerskiy. Zhurnal tekhnicheskoy fiziki, 21, 18, 1951.
2. V. L. Granovskiy. Izvestiya AN SSSR, ser. fiz., No. 4, 419, 1938.

Received 13 August 1950.



1 - $U=0$; 2 - $U=4000$ V; 3 - $U=5800$ V; 4 - $U=7600$ V.

sec = seconds

EAND

10 → 8

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